# EXECUTIVE SUMMARY

Under the direction of the U.S. Department of the Navy (Navy), Base Realignment and Closure Program Management Office West, and in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act, SulTech conducted a feasibility study (FS) for four sites at Operable Unit (OU)-1, Sites 6, 7, 8, and 16, at Alameda Point (formerly Naval Air Station Alameda).

This FS report was prepared based on the results of a remedial investigation (RI) report conducted at OU-1, which recommended further evaluations to address potential human health risks from soil and groundwater contamination at Sites 6, 7, 8, and 16 (Tetra Tech EM Inc. 2004). No sites were identified for further action based on ecological risk. Petroleum contamination at Site 7 was recommended for further action under the Total Petroleum Hydrocarbon (TPH) Program.

## REMEDIAL INVESTIGATION SUMMARY AND RECOMMENDATIONS

The RI report summarized the nature of each site, the anticipated reuse, and the chemicals of concern (COC) that the Navy intended to address. The text below provides an overview of the RI, including the recommendations, which were used to develop and evaluate remedial alternatives in this FS report.

The RI report for OU-1 concluded that groundwater contamination at Site 6 poses a possible inhalation risk to human health and that soil at Site 6 does not pose a significant risk to human health or to the environment. However, the RI did not sufficiently characterize soil adjacent to oil-water separators (OWS)-040A and -040B, which are recommended for further evaluation in this FS report. Groundwater COCs addressed in this FS report include the following volatile organic compounds (VOC): 1,2-dichloroethene (DCE), tetrachloroethene (PCE), trichloroethene (TCE), and vinyl chloride. These COCs are associated with the solvents used at Site 6. Site 6 is planned for reuse in the Civic Core (recreational/commercial/residential) and Marina District (recreational/residential) land use areas.

The RI report for OU-1 concluded that soil contamination at Site 7 poses a significant risk to human health in the soil debris area and that groundwater contamination at Site 7 does not pose a significant risk to human health or to the environment. However, the RI did not sufficiently characterize soil adjacent to OWS-459, which is recommended for further evaluation in this FS report. COCs in soil addressed in this FS report include arsenic, cadmium, and lead. Site 7 is planned for reuse in the Main Street Neighborhoods (residential) land use area.

The RI report for OU-1 concluded that soil contamination at Site 8 poses a significant risk to human health in the pink background area and that groundwater contamination at Site 8 does not pose a significant risk to human health or to the environment. However, the RI did not sufficiently characterize soil adjacent to OWS-114, which is recommended for further evaluation in this FS report. COCs in soil to be addressed in this FS report include lead, Aroclor-1254, Aroclor-1260, and dieldrin. Site 8 is planned for reuse in the Civic Core (recreational/commercial/ residential) land use area.

The RI report for OU-1 concluded that groundwater contamination at Site 16 poses a significant risk to human health from exposure to VOCs and that soil contamination at Site 16 does not pose a significant risk to human health or to the environment, except for polychlorinated biphenyl (PCB) contamination that was not adequately characterized during the RI. Additionally, the RI report did not sufficiently characterize soil adjacent to OWS-808A and OWS-608B, which are recommended for further evaluation in this FS report. COCs in groundwater addressed in this FS report include 1,3-dichlorobenzene (DCB), 1,4-DCB, PCE, TCE, and vinyl chloride, which are associated with the solvents used at Site 16. Site 16 is planned for reuse in the Inner Harbor (recreational/industrial) land use area.

The RI report made the recommendations listed below for soil and groundwater at each site (Tetra Tech 2004).

**Soil**

- **Site 6** - Characterize potentially contaminated soil and groundwater near OWS-040A and OWS-040B.
- **Site 7** - Further characterize soil debris area and address potential site risk to residential receptors from contaminated soil in the soil debris area and from potentially contaminated soil near OWS-459.
- **Site 8** - Characterize potential site risk to commercial/industrial worker receptors from contaminated and potentially contaminated soil near OWS-114.
- **Site 16** - Address potential site risk to commercial/industrial receptors from PCB-contaminated and potentially contaminated soil near OWS-608A and OWS-608B.

**Groundwater**

- **Site 6** - Address potential site risk to commercial/industrial worker receptors from groundwater containing chlorinated VOCs (PCE, TCE, and vinyl chloride).
- **Site 7** - Further characterize groundwater beneath OWS-459 for metals, VOCs, semivolatile organic compounds (SVOC), and pesticides, and evaluate groundwater remediation if results indicate groundwater contamination.
- **Site 8** - Further characterize groundwater beneath OWS-114 for metals, VOCs, SVOCs, and pesticides, and evaluate groundwater remediation if results indicate groundwater contamination.
- **Site 16** - Address potential site risk to residential receptors from domestic use of groundwater containing chlorinated VOCs (such as DCB, PCE, TCE, and vinyl chloride).

## FEASIBILITY STUDY APPROACH

The purpose of the FS is to develop and evaluate a range of alternatives that (1) eliminates or reduces human health exposure in soil and groundwater; (2) minimizes effects of contaminants on the environment; and (3) are feasible, implementable, and cost effective.

The typical FS process of developing and evaluating remedial actions consists of the steps below.

- Develop remedial action objectives (RAO) that specify contaminants and media of concern, exposure pathways, and remediation goals. RAOs are developed based on applicable or relevant and appropriate requirements (ARAR), results of the human health risk assessment, and results of the ecological risk assessment.
- Develop general response actions (GRA) for each medium to address the RAOs. Consider containment, treatment, removal, or other actions singly or in combination in developing GRAs.
- Identify the volume of each affected medium of concern.
- Identify and screen technologies for each GRA to eliminate technologies that cannot be implemented or are not cost effective.
- Identify and screen process options for each technology.
- Assemble retained process options into alternatives and screen the alternatives.
- Conduct a detailed analysis of the remaining alternatives in accordance with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) [Title 40 *Code of Federal Regulations* Section (§) 300.430(e)(9)].

U.S. Environmental Protection Agency (EPA) guidance states that where "circumstances limit the number of available options and therefore, the number of alternatives that are developed, it may not be necessary to screen alternatives prior to the detailed analysis" (EPA 1988). Based on the contamination detected at the four sites within OU-1, the selection of alternatives in this FS report was streamlined for soil and was not streamlined for groundwater.

For soil at each of the sites, no action, institutional controls, and excavation were generally evaluated. Contamination in soil at each site is generally at shallow depths and of moderate quantity. Thus, institutional controls and excavation are the most practical and cost-effective remedial alternatives for these sites.

## FEASIBILITY STUDY EVALUATION

Based on the information presented in the RI report and on the ARARs, RAOs and remedial action goals were developed for this FS report. RAOs can be achieved either by reducing COCs or eliminating the exposure pathways.

This FS evaluation considers alternatives for both approaches by media.

## Remedial Action Objectives

The RAOs below were identified for soil at each site within OU-1.

- **Site 6** - Prevent human exposure to soils adjacent to OWS-040A and OWS-040B that are found to contain VOCs, SVOCs, metals, pesticides, or PCBs at concentrations exceeding their respective residential preliminary remediation goal (PRG).

- **Site 7** - For all receptors at Site 7, prevent any exposures to soil contamination located adjacent to OWS-459 that exceeds the residential PRGs. For the residential receptor at Site 7, prevent dermal contact and ingestion of soils that exceed the following concentrations: 9.1 milligrams per kilogram (mg/kg) of arsenic, 1.7 mg/kg of cadmium, and 230 mg/kg of lead

- **Site 8** - For human receptors at Site 8, prevent any exposures to soil contamination located adjacent to OWS-114 that exceeds the residential PRGs. For the potential residential receptor at Site 8, prevent dermal contact and ingestion of soils that exceed the following concentrations: 0.22 mg/kg of Aroclor-1254 or Aroclor-1260 or 1 mg/kg total PCBs, 0.03 mg/kg of dieldrin, and 230 mg/kg of lead. For the commercial/industrial receptor, prevent dermal contact and ingestion of soils that exceed the following concentrations: 0.74 mg/kg of Aroclor-1254 or Aroclor-1260, 0.11 mg/kg of dieldrin, and 3,572 mg/kg of lead.

- **Site 16** - Prevent human exposures to soils adjacent to OWS-608A and OWS-608B that are found to contain metals, VOCs, SVOCs, pesticides, or PCBs (in contaminated soil in the storage area) that exceed their respective residential PRGs concentrations.

The following RAOs were identified for groundwater at each site within OU-1.

- **Site 6** - For the potential residential receptor, prevent inhalation of VOCs in groundwater that exceed the following concentrations: 8,800 µg/L of 1,2-DCE, 20 µg/L of PCE, 1.7 µg/L of TCE, and 5.9 µg/L of vinyl chloride. For the commercial/industrial receptor, prevent inhalation of indoor air containing VOCs from the groundwater plumes that exceed the following concentrations: 420 µg/L of PCE, 37 µg/L of TCE, 121,000 µg/L of 1,2-DCE, and 240 µg/L of vinyl chloride.

- **Site 16** - For the potential residential receptor, prevent dermal contact, ingestion, and inhalation of VOCs in groundwater at concentrations above MCLs. For the commercial/industrial worker receptor, prevent inhalation of indoor air containing VOCs from the groundwater plumes that exceed the following concentrations: 420 µg/L of PCE, 37 µg/L of TCE, 18,000 µg/L of 1,3-DCB, 3,000 µg/L of 1,4-DCB, and 240 µg/L of vinyl chloride.

## General Response Actions and Remedial Alternatives

GRAs and remedial alternatives for soil and groundwater were developed and evaluated to address the RAOs, as discussed below.

### Soil

For soil at Sites 6, 8, and 16, the following three GRAs were identified to address known or potential soil contamination.

1. No action
2. Institutional controls
3. Excavation with off-site disposal

GRAs 2 and 3 include collection of soil samples around the OWSs at Sites 6, 8, and 16. Also, the regulatory agencies identified the need for further characterization of potential PCB contamination at Site 16; therefore, GRA 2 includes collection of additional soil samples to characterize soil for PCBs at Site 16.

For soil at Site 7, the following GRAs were identified for contaminated soils.

1. No action
2. Excavation with off-site disposal
3. Treatment

However, a debris area at Site 7 poses unacceptable risk to human health; therefore, treating soil is not practical, so only the following two GRAs were considered: (1) no action and (2) excavation with off-site disposal. Because the debris area surrounds the OWS and contamination may extend beneath or beyond Building 459 at Site 7, collection of soil samples was included in the cost of Alternative 2.

Each of the alternatives for the four sites was evaluated against the two NCP threshold criteria (overall protection of human health and the environment and compliance with ARARs) and against the following five primary balancing criteria:

- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, and volume through treatment
- Short-term effectiveness
- Implementability
- Cost

Results of this evaluation were used to compare the remedial alternatives with each other. The two NCP modifying criteria (state and community acceptance) will be evaluated following public and regulatory agency comments on this FS report.

Based on the NCP threshold evaluation, Alternative 1 (no action) provides the lowest degree of protectiveness and is not acceptable at any site where evaluated, although its cost would be zero. Alternative 2 would protect human health and comply with ARARs, but not allow unrestricted use of the sites. Alternative 3 would protect human health, would comply with ARARs, and would allow unrestricted use of the sites. Details of the primary balancing criteria evaluation are provided in the text, and the supporting cost estimates are presented in Appendix C.

**Groundwater**

For groundwater, the three GRAs below were identified for achieving the RAOs.

1. No action
2. Land use controls (LUC), consisting of institutional controls and engineering controls
3. Active remediation

Technologies and process options for each remedial alternative (except no action) were identified and subjected to a preliminary screening at Sites 6 and 16. Monitoring and various LUCs were retained as part of the remedial alternatives. In addition, active treatment technologies were retained at Site 6, including air sparging, in situ chemical oxidation (ISCO), and enhanced bioremediation with hydrogen releasing compounds (HRC). For Site 16, retained treatment technologies were ISCO, HRC, pump and treat with air stripping, and pump and treat with chemical/ultraviolet oxidation. The retained treatment technologies were screened a second time against the following three criteria: effectiveness, implementability, and cost. Based on the second screening, ISCO and HRC were lowest in cost and were the most effective active treatment technologies that could be implemented within a reasonable timeframe

Using the two selected active treatment technologies (ISCO and HRC) in combination with other GRAs (monitoring and LUCs), the following four remedial alternatives were developed for Sites 6 and 16:

1. No action
2. Monitoring and LUCs
3. Active groundwater treatment (high target concentrations) with either ISCO (3A) or HRC (3B), monitoring, and LUCs
4. Active groundwater treatment (low target concentrations) with either ISCO (4A) or HRC (4B) and LUCs.

The no-action alternative was evaluated as a requirement of the NCP to provide a baseline for comparison; it is not considered to be an alternative that meets the RAOs.

Alternative 2 includes the key components listed below.

- No active groundwater treatment
- Monitoring for a period of 30 years to measure decreases in concentrations of COCs in groundwater until remediation goals under a commercial/industrial reuse scenario are reached
- Institutional controls to prevent domestic use of groundwater until remediation goals for domestic use are reached
- Institutional controls requiring vapor barrier/removal systems in new buildings constructed above the COC plumes until remediation goals for vapor intrusion are reached
- Engineering controls in existing buildings above plumes (necessary only if vapor monitoring indicates that TCE or vinyl chloride concentrations in indoor air exceed the remediation goal)

Alternatives 3A and 3B include the key components listed below.

- Active treatment with ISCO (Alternative 3A) or HRC (Alternative 3B) until concentrations of COCs in groundwater range from 2 to 12 µg/L
- After treatment, perform monitoring until concentrations of COCs in groundwater reach the remediation goals for domestic use (30 years predicted based on model)
- Institutional controls to prevent domestic use of groundwater until remediation goals for domestic use are reached
- Institutional controls requiring vapor barrier/removal systems in new buildings constructed above the COC plumes until remediation goals for vapor intrusion are reached (30 years predicted based on model)
- Engineering controls in existing buildings above plumes (necessary only if vapor monitoring indicates that concentrations of COCs in indoor air exceed the remediation goal)

Alternatives 4A and 4B include the key components listed below.

- Treatment with ISCO (Alternative 4A) or HRC (Alternative 4B) until all COC concentrations reach 0.5 µg/L, the remediation goal for domestic use for vinyl chloride

- Institutional controls, as described above for Alternatives 3A and 3B, until active treatment is completed

- Institutional controls requiring vapor barrier/removal systems in new buildings constructed above the COC plumes until remediation goals for vapor intrusion are reached

- Engineering controls in existing buildings above plumes (necessary only if vapor monitoring indicates that concentrations of COCs in indoor air exceed the remediation goal)

Each of the alternatives was evaluated against the NCP threshold and primary balancing criteria. The alternatives will be evaluated against the two other NCP modifying criteria, state and community acceptance, after public and regulatory agency comments on this FS report are received.

Based on the evaluation against the NCP threshold criteria, Alternative 1 (no action) provides the lowest degree of protectiveness and is not acceptable. Alternatives 2, 3A, 3B, 4A, and 4B would each protect human health, comply with ARARs, and allow unrestricted use of the sites at some point in the future.

Results of the evaluation against the NCP primary balancing criteria indicated that Alternative 2 may take 30 years to reach remediation goals for commercial/industrial use, whereas Alternatives 3A, 3B, 4A, and 4B provide active groundwater treatment to reduce concentrations of VOCs to remediation goals for domestic use within 5 to 34 years. Alternatives 2 through 4B include ICs to prevent domestic use of groundwater until remediation goals for domestic use are reached and to prevent exposure from vapor intrusion to indoor air. Alternatives 2 through 4B also provide protection against indoor vapor intrusion through deed restrictions requiring future buildings to install vapor removal systems in buildings currently located over the plume where vapor intrusion of COCs poses risk (Building 41 at Site 6 and Building 608 at Site 16). Based on modeling, the inhalation remediation goals can be achieved within a shorter timeframe than the remediation goals for domestic use. Tables 5-8 and 8-8 of the FS report summarize the evaluation against primary balancing criteria for Sites 6 and 16, respectively, and Appendix C provides the supporting costs.

The Navy will use this FS to prepare a proposed plan for public comment. The proposed plan will recommend one of the alternatives identified in this FS report. After considering regulatory agency and community acceptance, the Navy will issue a record of decision containing the selected final remedy.